Baryon-Strangeness correlations in Parton/Hadron transport model for Au + Au collisions at $\sqrt{s_{NN}} =$ 200 GeV

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Abstract.

Baryon-strangeness correlation (C_{BS}) has been investigated with a multi-p transport model (AMPT) in ^{197}Au + ^{197}Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. centrality dependence of C_{BS} is presented within the model, from partonic phas hadronic matter. We find that the system still reserve partial predicted signature C_{BS} after parton coalescence. But after hadronic rescattering, the predicted signat will be obliterated completely. So it seems that both coalescence hadronization pro and hadronic rescattering are responsible for the disappearance of the C_{BS} signat

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1. Introduction

Ultra-relativistic heavy ion collision may provide sufficient conditions for the format of a deconfined plasma of quarks and gluons [1]. Experimental results from R indicate that a strongly-interacting partonic matter (termed sQGP) has been create the early stage of central Au + Au collisions at $\sqrt{s_{NN}} = 200$ GeV at RHIC [2]. In or to uncover the nature of this matter, probes based on fluctuations have been propo throughout the last decade [3, 4, 5]. Recently a novel event-by-event observable been introduced by Koch et al. [6], i.e. the baryon-strangeness correlation coeffici C_{BS}.

The correlation coefficient C_{BS} is defined as

$$C_{BS} = -3\frac{\sigma_{BS}}{\ldots} = -3\frac{\langle BS\rangle - \langle B\rangle\langle S\rangle}{\ldots}$$

where B is the baryon charge and S is the strangeness in a given event.

This correlation is proposed as a tool to specify the nature of the highly compres and heated matter created in heavy-ion collisions [7]. The idea is from that the relat between baryon number and strangeness will be different when the phase of systen different. On the one hand, if the basic degrees of freedom are weakly interacting qua and gluons, the strangeness is carried exclusively by the s and $\bar{s}$ quarks, B_S=-$\frac{1}{3}$ Thus the correlation coefficient C_{BS}=1. On the other hand, if the degrees of freed are hadronic matter, the case is different because the baryon-strangeness correlat coefficient strictly depends on the hadronic environments. For example, in a syst composed of kaons the coefficient $C_{BS} \approx 0$, but $C_{BS} \approx 1.5$ for Cascades system.

In this article, we study the correlation coefficient with the AMPT model which consists of four main components: the initial conditions, partonic interactio hadronization and hadronic rescattering. The initial conditions, which include spatial and momentum distributions of minijet partons and soft string excitations, obtained from HIJING model [9]. In the default version of AMPT model (i.e. default AMPT) [11], minijet partons are recombined with their parent strings w they stop interactions. Then the resulting strings and the initial excited strings converted to hadrons using the Lund string fragmentation model [12]. In the str melting version of the AMPT model (i.e. the string melting AMPT) [13], the ini matter fragments into partons. A quark coalescence model is used to combine part to form hadrons. In the two versions, scatterings among partons including the result partons and the initial minijet partons are modelled by Zhang's parton cascade mo (ZPC) [10], meanwhile, dynamics of the hadronic matter is described by A Relativi Transport (ART) model [14]. Details of the AMPT model can be found in a rec review [8]. Previous studies [15, 16] demonstrated that the partonic effect cannot neglected and the string melting AMPT model is much more appropriate than default AMPT model in describing nucleus-nucleus collisions at RHIC. In the pres work, the parton interaction cross section in the AMPT model is assumed to be 10 which is the same as we used in our previous publications [15, 16, 17].

2. Results

Because the default AMPT is based on string mechanisms it provides an estimate of C value in the case where no partonic matter is created. And the string melting AM is based on strong parton cascade, therefore it provides an estimate of C_{BS} value the partonic matter is created. So we can compare the values of C_{BS} in the two mo versions to learn information about partonic matter at RHIC.

Firstly, we study the partonic phase with the string melting AMPT. we will cho appropriate pseudorapidity windows and study the effect of parton cascade.

In an uncorrelated partonic phase, $\sigma^2_{us} \approx 0$ and $\sigma^2_{ds} \approx 0$, we get $C_{BS} \approx 1$. The res
from the lattice QCD also predicted $C_{BS} \approx 1$ above T_C. So models of the deconfi
matter should obey such constraints.

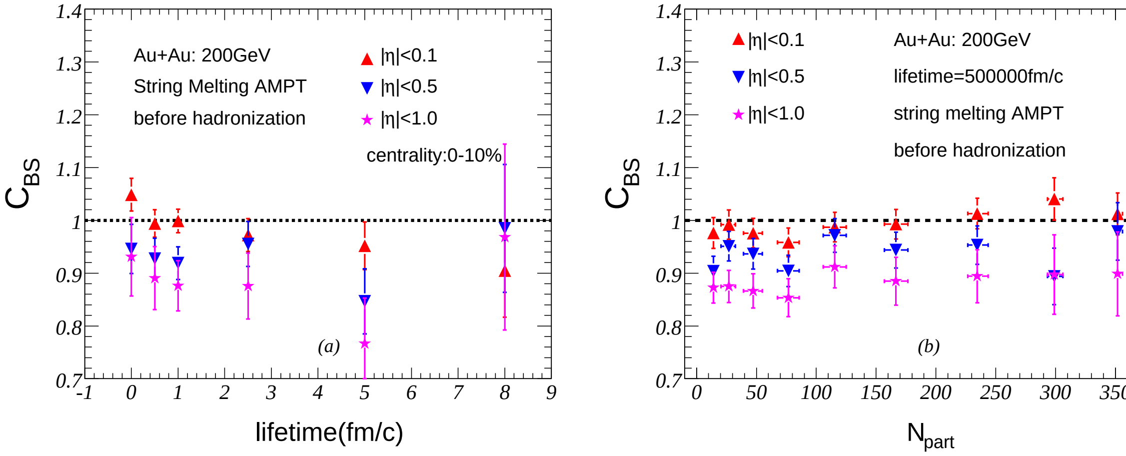

Figure 1. (a) The time evolution of baryon-strangeness correlation coefficient C_{BS}
partonic matter at η_{max}=0.1, 0.5 and 1.0; (b) The dependence of C_{BS} on the num
of participant particles in different pseudorapidity windows, namely η_{max} = 0.1,
and 1.0 for an infinite lifetime of partonic matter.

Fig. 1 (a) depicts the time evolution of C_{BS} of partonic matter. We find C_{BS}
1 with increasing time of parton cascade in different pseudorapidity windows 0.1 a
0.5, even for an infinite partonic lifetime. Therefore we conclude that in the ab
pseudorapidity windows parton cascade does not influence C_{BS}. But Fig. 1 shows t
when η_{max} = 1.0, the conditions that σ^2_{us}=0 and σ^2_{ds}=0 are not perfectly satisfied a
long parton cascade period. Therefore, we will focus on the correlations only in the
pseudo-rapidity windows, namely η_{max} = 0.1 or 0.5. In the following work, we pres
hadronic C_{BS} including all hadrons with masses up to that of Ω^-.

In AMPT model, hadronization is described with a coalescence model, and
pseudo-rapidity distribution will change during this process. After hadronization,
strangeness will be enhanced, so the C_{BS} will drop. In the following work, we can
that.

In Fig. 2(a) C_{BS} is depicted as a function of the number of participant parti
(N_{part}). For small acceptance windows around mid-pseudo-rapidity, C_{BS} stays roug
constant. The value of C_{BS} may be estimated as simply the ratio of probability
observe a strange baryon to that of strange meson [18]; 0.5 for the string melting AM
and 0.35 for the default AMPT. In this case, it is concluded that if the deconfined ph
exists, the ratio of multiplicity of strange baryon to that of strange meson will
enhanced before hadron rescattering. For η_{max}=0.1, the pseudo-rapidity windows r

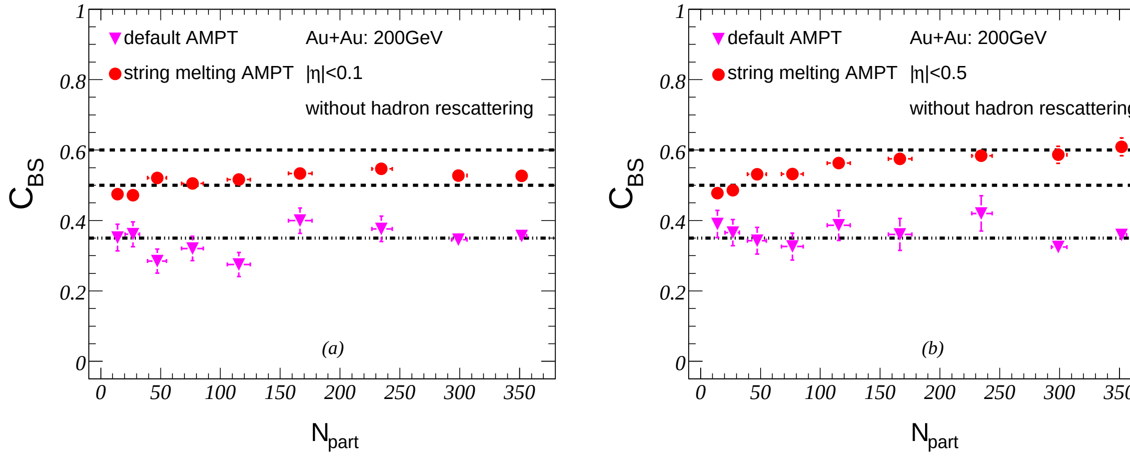

Figure 2. C_{BS} as a function of N_{part} at the η_{max}=0.1 (a) and η_{max}=0.5 in the default AMPT and the string melting AMPT without hadronic rescatter respectively.

melting AMPT because of higher baryon density. For central collisions C_{BS} goes to 0.6 and becomes flat. But for the default AMPT, C_{BS} still stays roughly const because of fragmentation mechanism. The results are consistent with [7]. From Fig. 2 we can say there exists an enhanced C_{BS} for central collisions if there is a partonic ph before the hadronic rescattering.

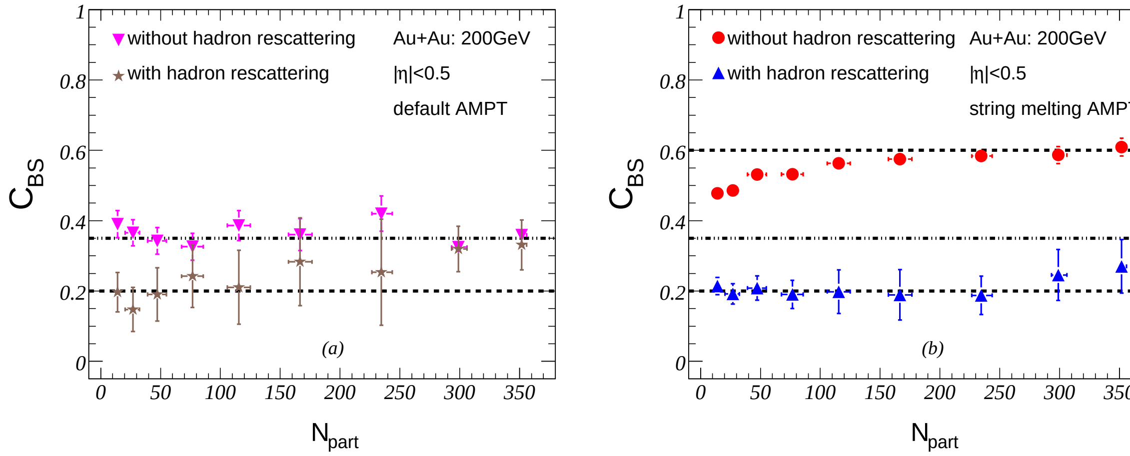

Figure 3. C_{BS} as a function of N_{part} at the η_{max}=0.5 in the default AMPT and the string melting AMPT (b) without hadronic rescattering and with hadr rescattering.

We also investigate the effect of hadronic rescattering which is shown in Fig We find the hadronic rescattering has a larger effect on the C_{BS} for the string melt AMPT simulation than that of the default AMPT from Fig. 3(b). For the default

signal of partonic matter as shown in Fig. 4.

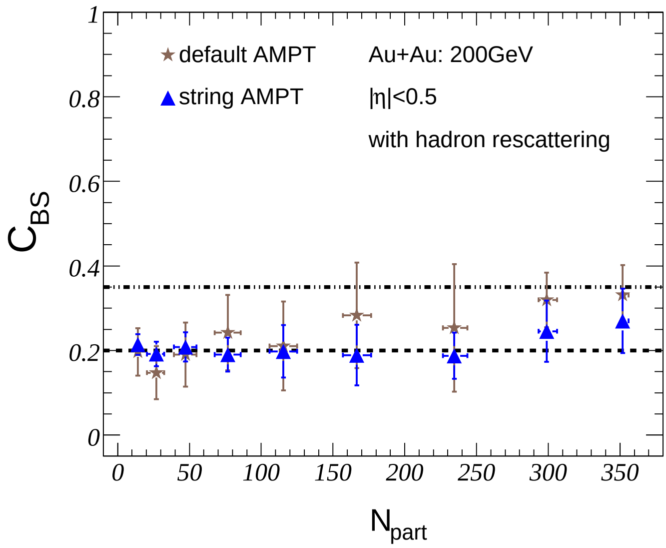

Figure 4. C_{BS} as a function of N_{part} at η_{max} = 0.5 in the default AMPT and
string melting AMPT with hadronic rescattering.

Finally, we try to choose a particle subset to see how much hadronic rescatter
effect on the C_{BS}. Here, the subset only includes Kaons and Protons. We find
value of C_{BS} goes down to 0.2 from Fig. 5. But after hadronic rescattering we
the similar results that hadronic rescattering finally obliterates the signals of parto
matter completely.

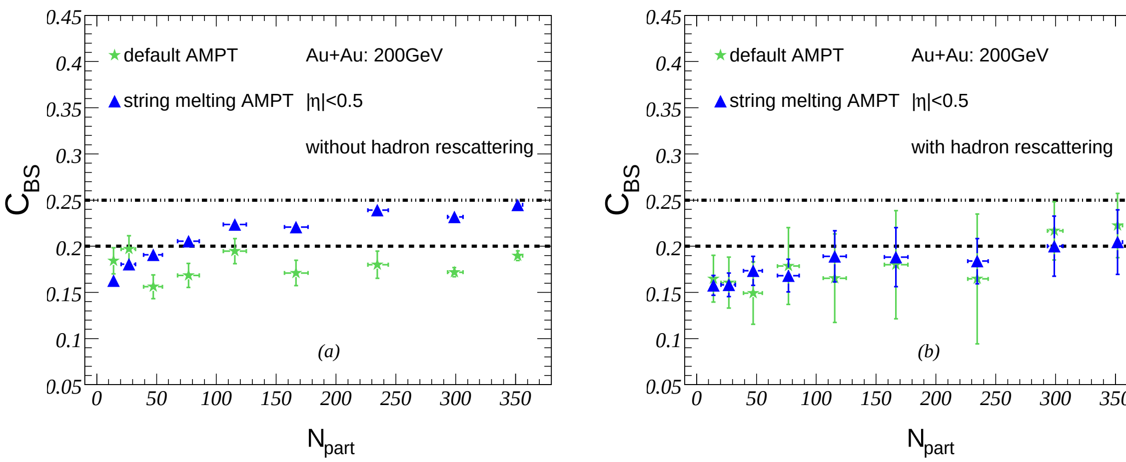

Figure 5. C_{BS} of Kaons and Protons combination as a function of N_{part} at the η
= 0.5 in the default AMPT and the string melting AMPT without(a) or with hadr
rescattering(b).

3. Summary

We have studied the dependence of the C_{BS} as a function of the N_{part} with a multi-ph transport model. At $\eta_{max} = 0.5$, we find the hadronazation makes the C_{BS} value dr but we still obtain the residual signal. However, after the hadronic rescattering, residual signal will be washed out. In order to analyze the effect of hadronic rescatteri we choose a special particle group which only includes kaons and protons, but the res does not help. Up till now, there are no powerful fluctuation probes of the deconfi matter in the experiment, perhaps both hadronization and hadronic rescattering effe may be responsible for the disappearance of the signals.

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